

[0038] Employing backlighting in accordance with the present invention overcomes the problems associated with fiducial 74 feature misalignment, because fiducial 74 functions as an aperture stop for radiation 94. As a result, the smallest cross-section presented by fiducial 74 to radiation 94 traversing axis 100 defines the circumference of emergent flux 96 and, therefore, fiducial 74. In this fashion, the circumference of emergent flux 96 is independent of the side of workpiece 22 facing detector 72a.

[0039] Referring to FIGS. 11 and 12, to facilitate backlighting, platen 25 includes one or more illumination sources 78. As discussed above, a surface 104 of platen 25 includes a plurality of vacuum grooves 106 and 108 formed therein. A first subgroup 106 of the plurality of vacuum grooves extends along a first direction, and a second subgroup of the plurality of vacuum grooves 108 extends along a second direction, transversely to the first direction. Although any illumination source 78 may be employed, it is desired to provide an illumination source 78 that emits a wavelength of electromagnetic radiation to which photo-sensitive layer 80 will not be responsive. In one application, illumination source 78 comprises of electroluminescent material that emits wavelengths of electromagnetic radiation in the range of 410-620 nm. This range of wavelengths is desired, because photo-sensitive material 80 is typically material selected to be responsive to ultraviolet wavelengths.

[0040] Referring to both FIGS. 9 and 12, illumination source 78 is disposed in a recess 110 formed into surface 104. Recess 110 has a nadir 112. A body of glass 114 is disposed within recess 110, with illumination source 78 being disposed between body 114 and nadir 112. Body of glass 114 has sufficient thickness to ensure that the surface thereof, disposed opposite to illumination source 78, lies in a common plane, shown as 116, with surface 104. In this manner, the surface of platen 25 to which workpiece 22 is exposed is planar, which ensures that illumination source 78 is positioned as close to fiducial 74 as possible. This provides a maximum radiance of electromagnetic radiation propagating through fiducial 74. It should be understood however, that the need for body of glass 114 may be abrogated by providing illumination source 78 with sufficient thickness so as to extend from nadir surface 112 to common plane 116, shown in FIG. 13.

[0041] Referring again to both FIGS. 9 and 12, to relax the requirement of proximity between illumination source 78 and fiducial 74, body of glass 114 may be in the form of a projection lens. Alternatively, or in addition to, the projection lens, diodes emitting, for example, infra-red or near infra-red radiation, may be employed as illumination source 78. Also, semiconductor laser diodes may be employed. In this manner, collimated light may be provided which will abrogate the need for the projection lens or to place workpiece 22 in close proximity to illumination source 78.

[0042] Referring to FIG. 14, platen 125 may be formed from a body of glass having opposed surfaces 204a and 204b surfaces, with illumination source 178 being disposed adjacent to surface 204b. Surface 204a includes the plurality of vacuum grooves 106 formed therein. In this manner, vacuum grooves 106 are disposed between illumination source 178 and the detector (not shown).

[0043] Referring to both FIGS. 5 and 15, to align workpiece 22 and tool 24, the position between tool 24 and platen

25 is programmed into a memory 130 that is in data communication with processor 34 at step 300. Rough alignment between workpiece 22 and tool 24 is then achieved by placing the workpiece 22 against banking pins 22a at step 302. Specifically, banking pins 22a place workpiece 22 into a predefined positional relationship with platen 25, thereby providing course alignment between workpiece 22 and tool 24. At step 304, vacuum system 29 is activated to form a vacuum in vacuum grooves 27 to hold workpiece 22 flat against platen 25. Employing laser range finder 72b, stage 28 is moved in the z direction to optimize the imaging capabilities of tool 24, which coincides with the optimal focus for detector 72a, referred to as leveling workpiece 22, at step 306. This is achieved by analyzing three regions of workpiece 22. The regions are selected to define a triangle, were a line drawn therebetween. The regions are selected so that the triangle has a maximum area allowed while being completely encompassed by the area of workpiece 22. The triangle is associated with a plane in which workpiece 22 is to be disposed. Then processor 34 directs servo-mechanism 38 to move stage 28 in the z direction so that workpiece 22 lies in the aforementioned plane.

[0044] After leveling workpiece 22, stage 28 is moved to predetermined coordinates, programmed into memory 130, to superimpose a sensing area 73 of detector 72a with a fiducial at step 308. After reaching the predetermined coordinates, processor 34 operates on the signal generated by detector 72a in response to light sensed in sensing area 73. Specifically, electromagnetic radiation, such as light, created by illumination source 78 passes through fiducial 74 and detector 72a senses a flux of the light emerging from fiducial 74. Processor 34 ascertains whether a sufficient amount of light is present to indicate the presence of fiducial 74 within sensing area 73 at step 310. If no light is sensed, then stage 28 is moved to an additional set of predetermined coordinates where an additional fiducial is expected to be located at step 314. At least two fiducials must be sensed by detector 72a to align workpiece 22 and tool 24 properly.

[0045] If sufficient light is sensed within sensing area 73 to indicate that a fiducial is present, processor 34 calculates the circumference of fiducial 74. Specifically, processor 34 identifies the edge of fiducial 74 as a function of the optically contrasting regions sensed by detector 72a, at step 316. After the edge of fiducial 74 is identified, processor 34 fits a boundary line thereto, at step 318. The circumference of the boundary line is determined and analyzed to determine whether it is within acceptable tolerances, at step 320. For purposes of the present invention, circumference encompasses any shape or contour of boundary line that encompasses a region. This may include, but is not limited to, circular boundaries, polygonal boundaries, elliptical boundaries, asymmetric boundaries and the like.

[0046] Were the circumference found not be within acceptable tolerances, e.g., indicating that the entire fiducial 74 is not within sensing area 73, processor 34 could calculate trajectory information to move stage 28 in the appropriate x-y direction to bring the entire fiducial 74 within sensing area 73, at step 322. Were the circumference found to be within acceptable tolerances, then fiducial 74 is considered to be registered properly, and a fiducial coordinate is ascertained, such as a centroid of the region encompassed by the boundary line, at step 324. At step 326, it is determined whether two fiducial coordinates have been ascertained, if